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BULLETIN OF THE
U.S. DEPARTMENT OF AGRICULTURE

No. 223

Contribution from the Bureau of Plant Industry, Wm. A. Taylor, Chief.
June 23, 1915.

(PROFESSIONAL PAPER.)

BOTANICAL CHARACTERS OF THE LEAVES OF THE DATE PALM USED IN DISTINGUISHING CULTIVATED VARIETIES.

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INTRODUCTION.

At the present time most students of the date rely largely, if not wholly, on the fruiting characters for means of distinguishing the numerous varieties.

While it is recognized that in the Old World date-growing countries the natives distinguish almost intuitively the different varieties of dates by the tree habit and leaf characters, but little attention has been given to these points by European and American students of the date and no attempt has been made to systematize these characters.

The date trees certainly possess such characters, and the varietal distinctions are as constant in the trunk and leaf as they are in the fruits.

From the beginning of the study of the imported date trees in the American gardens there has been felt the need of a method of comparing and describing the different trees in the absence of their fruit and independently of their fruit characters.

This becomes of importance in assisting date work along two very distinct lines—the identification and comparison of varieties, either imported or originating in this country, and the study of seedlings originating from the cross-pollination of different varieties.

NOTE.—This bulletin is of interest to date growers, especially in the Southwestern States.

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To enable the observer to make such foliage comparisons in a precise and systematic manner, capable of tabulation for future reference, is the most important use to which this study of date-foliage characters can be put.

Most of the workers in the date gardens of the Department of Agriculture soon learn to recognize the more prominent varieties by such obvious characters as a slender or a heavy trunk; leaves with broad or narrow rib bases, erect and rigid in growth or more or less spreading, feathery, and graceful. Less elementary characters are recognized, but not formulated, which would distinguish two varieties which might agree in the more fundamental points. There are differences in the broad outlines of the leaf blade as a whole and differences in the blade, as to whether it is smooth and nearly flat or whether from varying angles of the pinnæ it appears on the defensive with bayonet-like points thrust out in all directions, as if to resist assault.

Most persons who become familiar with date trees will distinguish between trees of varieties which possess many characters in common if they are side by side for comparison; fewer will be able to keep the resemblances and differences in mind if the compared trees are on opposite sides of the garden, and a still smaller number will be able to keep varietal characters clearly in mind in going from one locality to another.

The object of this study has been to determine just what varietal characters in date trees consist in; then to apply names and formulate these so that they may be used in classifying and determining varieties, much as floral and foliage characters are used by the systematic botanist.

Perhaps of all cultivated plants the date palm is the most mechanical or geometrical in its external structure. The cylindrical, columnar trunk has the overlapping leaf bases, like inverted tiles, arranged in broad right or left spirals. The rachis, or rib, is long, smooth, and rodlike, and its expansion toward the base is along symmetrically molded surfaces.

The leaflets, or pinnæ, are in symmetrical ranks from either side of the rib, and each individual has its polished sword-shaped blade folded lengthwise with the precision of machine work. In the unopened leaf the pinnæ are placed with the compactness of the ribs of a fan, and in expanding each assumes within certain limits a definite angle with the rachis peculiar to its class.

Having such features to deal with, the writer feels that no further explanation is needed for the very mechanical way in which the subject of date-tree characters is treated. It is the only method by which the subject can be approached.

THE DATE TREE.

Date trees have no true branches, but during their earlier years, and under some conditions up to a considerable age, buds are pushed in the axils of the leaves and later develop into suckers or offshoots. These, if left undisturbed, may form trunks and tops of their own and grow to a size second only to the parent tree and identical with it in leaf and fruit characters. When these offshoots are removed at a proper size and planted by themselves they afford the only means we have of propagating the parent variety true to type. (See Pl. I.)

The flower stalks of the date are produced from the axils of the leaves in similar positions to those in which the offshoots are produced.

While many genera of palms have either perfect or monœcious flowers, all species of the genus Phoenix are diœcious, the male and female flowers being borne on separate trees. In rare instances both pistillate and staminate flowers are produced on the same spike.[1]

In noticing a date tree closely, one finds only a central columnar trunk, from the one bud at the top of which new leaves are pushing out, while around its sides the older leaves clasp the stem with their broad-sheathed bases. If the tree has reached some age and the trunk has gained a few feet in height, the older lower leaves will probably have been cut away, leaving a foot or more of their bases arranged in orderly position around the trunk in the manner of reversed tiles. Closely wedged in between these are dozens of sheets of very tough, coarse-matted fiber, called "leef" by the Arabs, the remnants of the leaf sheaths. (Pl. II.) The real trunk of the date tree is inside of these and is greatly strengthened and protected by them. It is strengthened and supported by the wrapping of their tough fibers against the leverage of the desert winds, which exert a powerful pressure upon the broad top. It is protected from bruising and battering or the gnawing of grazing animals, and insulated alike against the intense heat or the sudden freezing weather of the winter months, which may descend upon even a date-growing desert.[2]

LEAF CHARACTERS OF THE DATE.

Upon a casual examination of a date leaf the most obvious feature is the long flexible blade, which may vary in length from 3 or 4 feet in a young plant to 9, 12, or even 16 feet in a tree of mature age. (Pl. III.)

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[1] As the various species of this genus hybridize readily with one another, the so-called date palms grown in many nurseries and sold for ornamental planting in California and Florida are often crossed to such an extent that the true *dactylifera* characters, as found in the trees obtained from the Sahara, are difficult to recognize, and the application of the rules laid down in this bulletin to such would lead to confusion.

[2] Date trees in Arizona and California subject for a few hours to a temperature of 15° or 18° F. may have the outer leaves killed, or at 12° F. all exposed leaves may be killed and the protected bud or growing point of the tree remain uninjured, so that new leaves are pushed from the center when spring opens.

The axis of this blade is a stout polished rib, technically called the rachis, which may be several inches broad where the leaf is attached to the trunk, but tapers to a slender tip of less than a quarter of an inch. (See Plate I.) As the leaves are placed on the trunk the face of the leaf, which is inward or toward the center of the tree, may be called the ventral surface. The reverse of this, away from the tree, is the dorsal surface. The right and left sides will be designated with the leaf in a vertical position and with the observer facing the trunk.

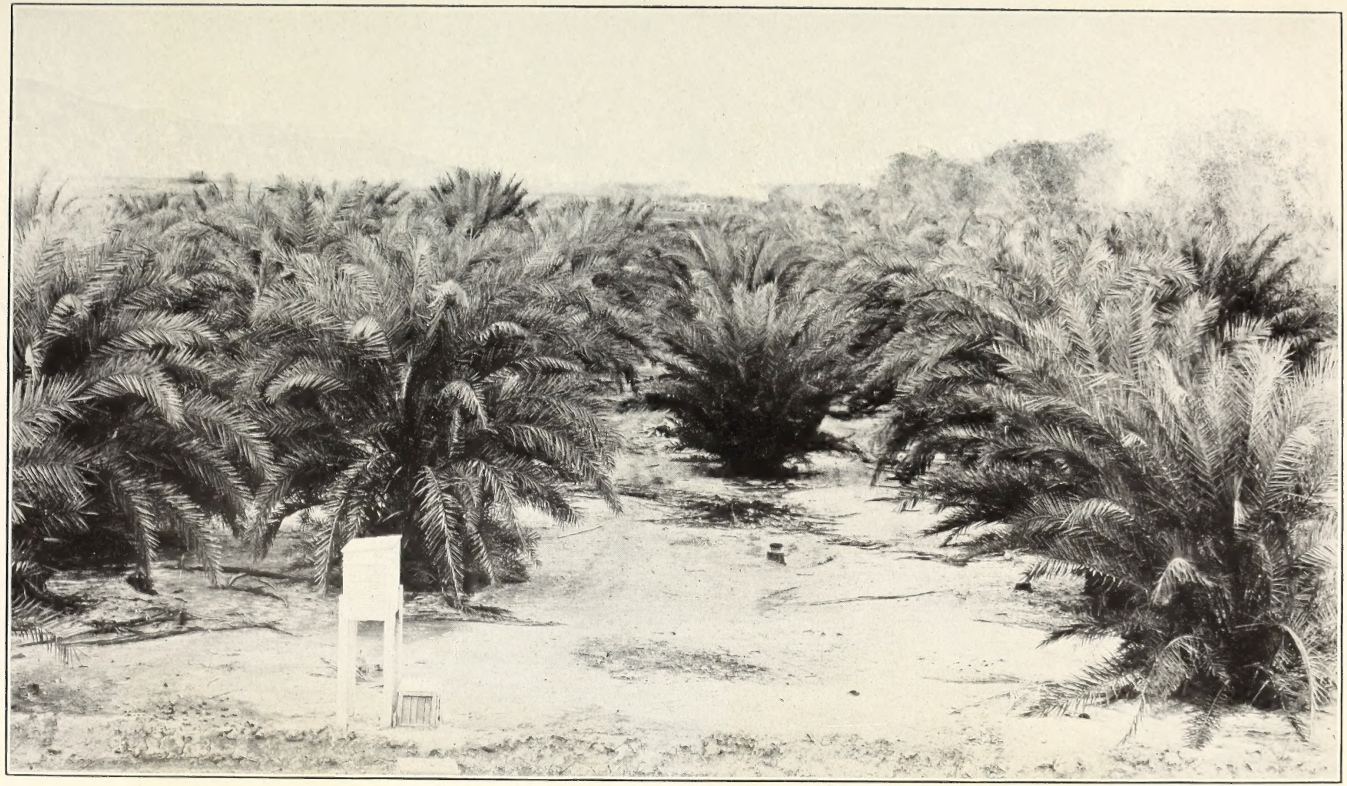
If an entire old leaf is cut away at its attachment to the trunk it will be found that the thick, wedge-shaped base shows torn and ragged margins, or perhaps a bit of matted fiber still clinging to it, where the fibrous sheath has been torn away. At the line of attachment sheets of this fiber encircle the tree. If a date palm be dissected, cutting away leaf after leaf till we get toward the bud, we find leaves with their original structure entire and the margins of the wide base of the rib thinning out to a continuous mat of brown fibers, which forms a complete sheath encircling all the younger growth. As the area of active growth is approached, near the center this sheath will be yellowish white, soft, and succulent, not more than 2 or 3 inches in diameter, and 8 inches or a foot in length. In a large tree the sheath may be 20 inches or more in length. On the opposite side from the rachis the margin of the sheath has an upward expansion into a broad lingua, or tongue, with coarsely incised margins and a blunt-pointed or an acuminate apex, which sometimes protrudes several inches against the inclosed leaves and which varies in a manner somewhat characteristic of different varieties. The diagonal arrangement of the fibers allows the sheath to expand a good deal, but the continual pushing upward of new leaves from within and the expansion of the trunk finally rupture it or tear it loose from the sides of the rib. Its lower margin remains attached to the trunk, so that this wrapping of old sheath fiber may persist for many years. In rare instances, the variety Lagoo, for example, the sheath has ear-shaped or auriculate expansions at the upper margin of its attachment to the rachis. Figure 1 shows a typical date leaf with the various parts.

An entire leaf comprises the upper expanded portion, properly called the blade, which includes the length from the first spines to the top, and the lower portion, representing the petiole, including the broad, wedge-shaped base of the rachis and the sheath. The blade is divided into the spine area and the pinnæ area, the exact separation of which sometimes can be only approximated. Varieties differ greatly in the proportion of the leaf blade occupied by the spines, which may range from 18 or 20 per cent to 45 per cent of the entire blade length.

A 9-YEAR-OLD DATE TREE IN THE COOPERATIVE DATE GARDEN, TEMPE, ARIZ.

A large number of offshoots, shown both at the base of the trunk and on its sides, are trimmed up and ready for removal.

A 20-YEAR-OLD MALE DATE PALM IN THE MECCA COOPERATIVE DATE GARDEN, MECCA, CAL.



COOPERATIVE DATE GARDEN AT TEMPE, ARIZ.

View looking west from the roof of the office building. The trees are shown 10 years after planting

A HAYANY DATE TREE, 10 YEARS OLD, AT THE TEMPE COOPERATIVE DATE GARDEN.

This tree shows a number of offshoots on the trunk, 3 or 4 feet from the ground; also graceful foliage and long, flexible "ribbon" pinnæ.

The broad outlines of the blade vary considerably with different varieties and are determined by the length of the pinnæ in different parts of the blade and the angles which they form with the rachis and plane. To illustrate: If in a given leaf the pinnæ at the middle of the blade are 16 inches long and placed at right angles, or 90°, with the rachis and lie in the plane of the blade; that is, so that the leaf is flat, the leaf will be 32 inches broad, not counting the breadth of the rachis fig. 2, *A*, *bb*). Let the same length of pinnæ be placed inclined only 45° from the rachis and still in the plane of the blade, then the blade will be but $22\frac{5}{8}$ inches broad (fig. 2, *A*, *cc*). But let the pinnæ, instead of lying flat (fig. 2, *B*, *b*) diverge 45° from the plane of the blade, as well as 45° from the rachis (fig. 2, *B*, *c*), then the leaf blade becomes a V-shaped trough only 16 inches broad, or half the breadth of the blade with the pinnæ flat and at right angles.

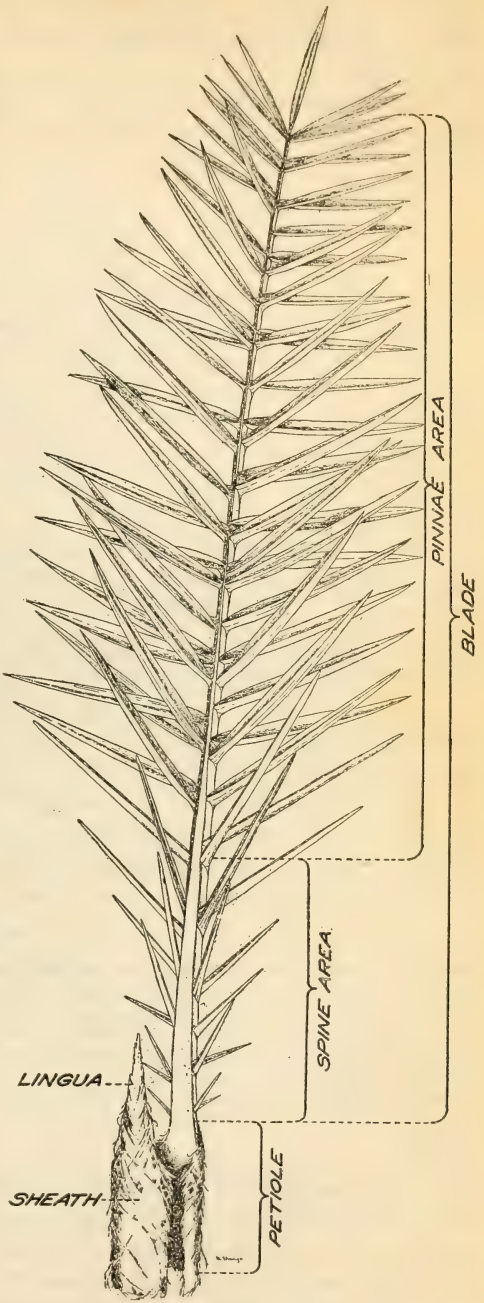


FIG. 1.—A typical date leaf, showing its various parts.

THE RACHIS.

A close inspection of the rachis of the date leaf shows that it is irregularly foursided; the inner or ventral surface is usually strongly arched or at the first spines is made up of two ogee curves turned together. The back or dorsal surface is moderately or often strongly rounded at the base, slightly rounded or rarely flattened toward the

top. The sides or lateral faces are flat or somewhat concave, and their inner margins, at first slightly converging, as they approach the top are drawn so near together as to give a triangular cross section to the rib.

The characteristic form or habit of tree tops of each date variety, due to the curves of the leaf blades, is largely determined by the flexibility of the rachis. This is governed in part by the degree of firmness and elasticity of the fiber of the rachis, but more by the way in which the diameter diminishes along the different faces.

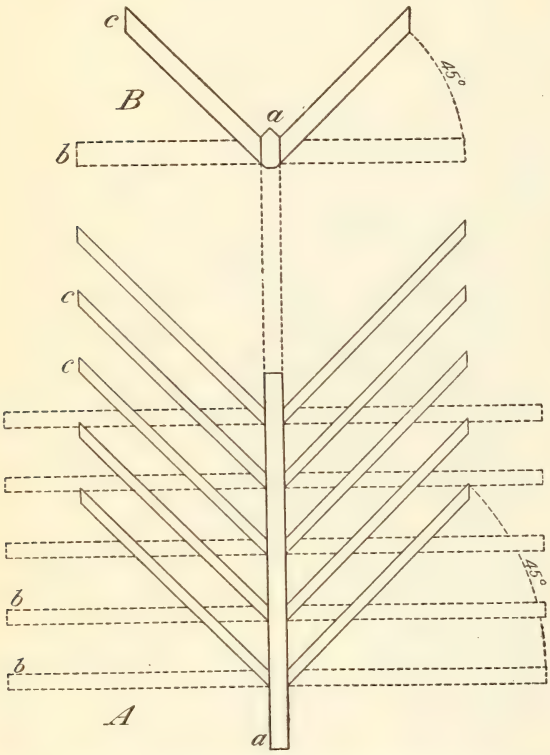


FIG. 2.—Diagram showing how the size of the date leaf is affected by the angles which the pinnæ form with the rachis. *A* represents the leaf as lying flat, the dotted lines (*b b*) showing the breadth the leaf would have with the pinnæ at 90° of axial divergence, the solid lines (*c c*) showing the breadth of the leaf with pinnæ diverging 45° from the axis. *B* represents a cross-section view of the leaf, *b* showing the pinnæ lying in the blade plane, or flat, but with an axial divergence of 45°; *c* shows the same pinnæ also diverging 45° from the blade plane.

The feathery grace of the Areshti variety is due to the leaves maintaining considerable rigidity in the lower portion, but with the rachis diminishing to a delicate and slender flexibility at the apex. The broad, open top and loose, lazy curves of the Rhars leaves are due to a rather rapid diminishing in the diameter of the rachis a short distance above the base, yet maintaining too much size in the apical portion to give grace or airiness. In the Thoory and other varieties of that class the thick, strong rachis holds its size and rigidity well up in the blade, curving only when forced out by the growth of the inner leaves. Such trees have a stiff and uncompromising aspect through the entire top.

The relative size and form of the rachis in different portions of the blade are so characteristic in the different varieties and such impor-

tant factors in determining the form assumed by the tree top that it has been thought worth while to make outline tracings of the cross sections of the rachis of leaves of the different varieties, four series of which are reproduced with the descriptions of the respective varieties as text figures in this bulletin. (See figs. 11, 13, 14, and 15.) The first section is in all cases made just below the lowest spines; that is, at the base of what has been defined as the blade of the leaf, the others 1 or 2 feet apart to the apex or near it.

THE PINNÆ.

The organs commonly called leaflets, or properly pinnæ, of the date leaf, including those suppressed as spines, number from 50 or 60 to 130 on each side of the rachis. The two sides of the leaf are fairly symmetrical as to the length of the pinnæ blades and the angles at which they are placed with the rachis, but not quite symmetrical in numbers, there sometimes being a difference of four or five pinnæ on opposite sides of the leaf. While the occurrence of pinnæ in pairs is not infrequent, it appears to be largely accidental, and with the general irregularity of their positions they can not be regarded as being paired and opposite in position in the sense in which the members of many compound leaves are so recorded.

The pinnæ are borne on the lateral faces of the rachis, with normally a single pinna at the apex. In Plates I and IV the terminal pinnæ show very plainly on a number of leaves.

On the lower part of the blade the leaflike pinnæ are replaced by stiff acute spines, from 1 inch to 7 or 8 inches in length. These are really modified pinnæ, as is clearly shown by the channel in one side corresponding to the fold of the pinnæ blade; also by their mode of attachment and arrangement in groups. The larger spines pass by gradations into stiff spinelike forms, which will be called spike pinnæ. Above these there are in some varieties extra long, narrow forms, so thin and weak as to be pendulous, which will be referred to in descriptions as ribbon pinnæ. In Plate IV the long, pendulous ribbon pinnæ can be noticed on the lower portion of several leaves.

Each pinna consists of a green, leathery, sword-shaped or ensiform blade, folded lengthwise, and a cushiony expansion or callus, called the pulvinus, by which it is attached to the rachis.

In a few varieties the lower pinnæ and some spines do not immediately broaden beyond the pulvinus into the thin blade, but have a short, solid, necklike portion, elliptical in cross section, for which the name collum (Latin for "neck") is proposed.

Toward the upper end of the leaf in certain varieties the folds of the pinnæ blade are somewhat unequal, the lower or proximal fold being a little broader than the upper one. Instead of being inserted directly into the rachis it is attached along the side, running down-

ward (decurrent) along the lateral face for an inch or two. With the fold of the blade slightly broader than the face of the rib, a free wing results, and a series of these with corresponding wings from the opposite side of the rachis may form a narrow channel along the middle of the inner face of the leaf. When such wings and channels are conspicuous they constitute good varietal characters and also are of some importance in affording harbors for scale insects, particularly *Phoenicococcus marlatti*.

When the new leaves issue from the center of the crown, three, making a complete circle of the stem, usually follow in close succession and are crowded into the form of an irregular cylinder. This gives to each emerging leaf the form of a third of a cylinder with an acuminate apex, the pinnæ being folded as compactly as the ribs of a fan upward against the rachis. With the expansion of the rachis the pinnæ diverge and the cushiony pulvinus at the base of each, at first scarcely noticeable, rapidly expands, pushing the pinna to its characteristic angle and holding it there securely.

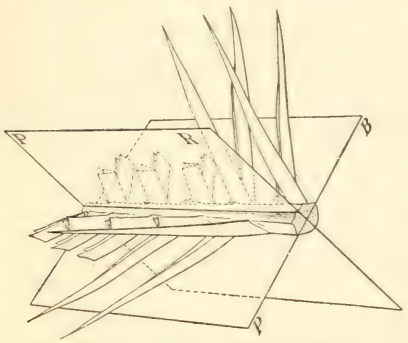


FIG. 3.—Diagram showing the construction of imaginary planes bisecting the date leaf longitudinally, by means of which the angles of divergence of the pinnæ from the rachis are read: *PR*, Plane of the axis, which would divide the leaf into right and left halves; *PB*, plane of the blade, dividing the leaf into dorsal and ventral halves.

ANGLES OF PINNÆ WITH THE RACHIS.

The difference in appearance of the leaves of varieties of dates is largely due to the different angles at which the pinnæ diverge from the rachis. At first sight these are confusing and are best understood by constructing two imaginary planes parallel with the leaf and vertical to each other. (See fig. 3.) Note (1) the plane of the blade (*PB*), which would divide the leaf into an inner or ventral half and an outer or dorsal half, and (2) the plane of the rachis (*PR*) at a right angle to the first and dividing the leaf into right and left halves.

If all pinnæ lay in the first plane there would be only two ranks, a right and a left rank, and the blade would be broad and flat, its outlines determined by the length and axial angles of the pinnæ. If the pinnæ were inserted vertically or at 90° to the second plane, they would project from either side like the teeth of a double comb.

Actually but few pinnæ in *Phoenix dactylifera* lie in either position, but the exact position of any pinna may be recorded with precision by determining its angle with each of these two planes.

It is not to be supposed that date leaves are so perfectly laid off along geometric lines that we have but to read a set of angles, refer to a table, and say with confidence, "this is Thoory," or "this is Hayany." But it is true that certain ranges of angles are found only in certain varieties, and, along with other characters, are important factors in identification.

PINNÆ CLASSES.

A third character in the insertion of the pinnæ remains. In all species of the genus Phœnix the folded pinnæ are attached to the rachis, with the margins and channel inward, or toward the ventral face of the leaf, and in some species, as *Phœnix canariensis*, they are quite uniformly attached with the channel directly inward, or at right angles with the blade plane.

In the date palm, while all the pinnæ face generally inward, or ventrally, only a portion of them face directly inward or at right angles to the blade plane. An important class of them are placed facing obliquely forward or upward, and about an equal number face obliquely backward or downward, thus giving three distinct classes of pinnæ as to position.

Those with the fold facing directly inward, or attached at right angles with the rib, will be called introrse,[1] using a botanical term meaning "directed inward."

A second class includes pinnæ with the channel directed obliquely upward, or toward the apex of the leaf, and for these the term antrorse,[2] meaning "directed upward or higher," will be used.

In a third class the pinnæ have the channel directed more or less obliquely, downward, or toward the base of the leaf, and the term retrorse,[3] meaning "directed back or downward," will be applied to these.

PINNÆ GROUPS.

Studying the pinnæ along the side of a leaf, we soon notice that these classes of pinnæ are not placed at random, but that there is a regularity in their succession. In other words, the pinnæ along the respective sides of the rachis are arranged in groups of two, three, four, or, rarely, five, a group of two being the most common. These groups fall into regular and irregular classes. The regular groups, which constitute the normal or regular form of arrangement, consist of a lower or proximal antrorse pinna and an upper or distal retrorse pinna, between which may occur one, two, or, rarely, three introrse pinnæ. Figure 4 shows the ventral surface and left side of a section of a rachis with the pinnæ cut to about an inch long. There are

[1] "Introrse, *intror'sus* (Mod. Lat.), turned inward, toward the axis."

[2] "Antrorse, *antror'sus* (antero-, before, *versus*, turned toward), directed upward, opposed to retrorse."

[3] "Retrorse, *retror'sum* (Lat.), directed backward or downward." (Jackson, A Glossary of Botanical Terms.)

four paired groups in succession, each of an antrorse pinna (*a*) and a retrorse pinna (*r*).

Figure 5, *A*, shows a ventral view of a section of a leaf, on the left side (*L*) of which, from below upward, is a triple group (*a*, *i*, *r*) and a paired group (*a*, *r*). On the opposite side (*R*) is a paired group below and a triple group above.

In figure 5, *B*, the right-hand side of a section cut well toward the top of the leaf shows a triple group below and a quadruple group above. It should be noted that the antrorse and retrorse pinnæ are not placed as obliquely as in those near the base of the blade.

In figure 5, *C*, the left-hand side of a section in about the middle of the blade shows a group of five pinnæ (*a*, *i*, *i*, *i*, *r*). This group is found in comparatively few varieties and only in small numbers.

Thus, there are four kinds of these regular groups. Noting them by the initial letters of the component pinnæ, they are, first, the

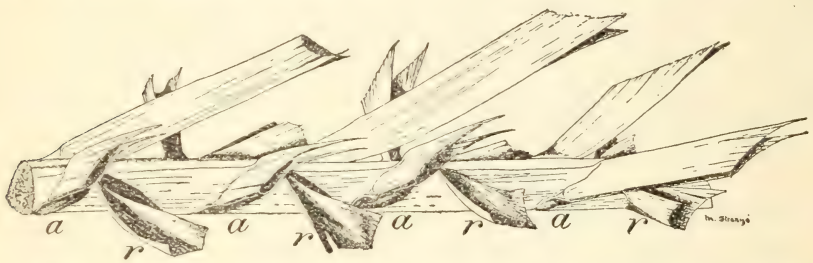


FIG. 4.—Section of a date leaf, showing the rachis and the bases of four paired groups of pinnæ, each group comprising an antrorse pinna (*a*) and a retrorse pinna (*r*).

simplest and most common paired group of an antrorse and a retrorse pinna (expressed as *a*, *r*); the triple group, with one intermediate introrse pinna (expressed *a*, *i*, *r*); the quadruple group, including two introrse pinnæ (*a*, *i*, *i*, *r*); and the quintuple (*a*, *i*, *i*, *i*, *r*).

Of irregular groups of pinnæ there is a great variety—*a*, *i*; *a*, *i*, *i*; *a*, *a*, *r*; *a*, *r*, *r*; *a*, *i*, *a*, *r*, etc. Often toward the apex of the blade the groups become obscured and the classes not well defined, merging into introrse pinnæ. In some varieties there is, especially toward the apex of the blade, a decided uniformity in leaflet insertion, the antrorse and retrorse pinnæ nearly disappear, and the groups are not well defined.

Figure 5, *D*, shows the left side of a section from a leaf of Areshti, cut near the top. Here no definite grouping could be made. The first, fourth, fifth, and seventh show a slightly oblique retrorse position, but such an area would be recorded as "indefinite."

In these the blade has nearly a plane surface, the pinnæ falling most nearly into two ranks. Where the grouping is most pronounced, six distinct ranks of pinnæ can be discerned, three on either side of the rachis. This is best noted by looking from the apex down

the trough, or valley, of the blade, the rib being on a level with the eye. The 6-ranked leaves have a ragged and aggressive appearance, and with their formidable thorns and acute pinna tips are most completely armed against predatory animals.

Examining the pinnæ of the three classes—antrorse, introrse, and retrorse—we find that each has its well-defined relative position of

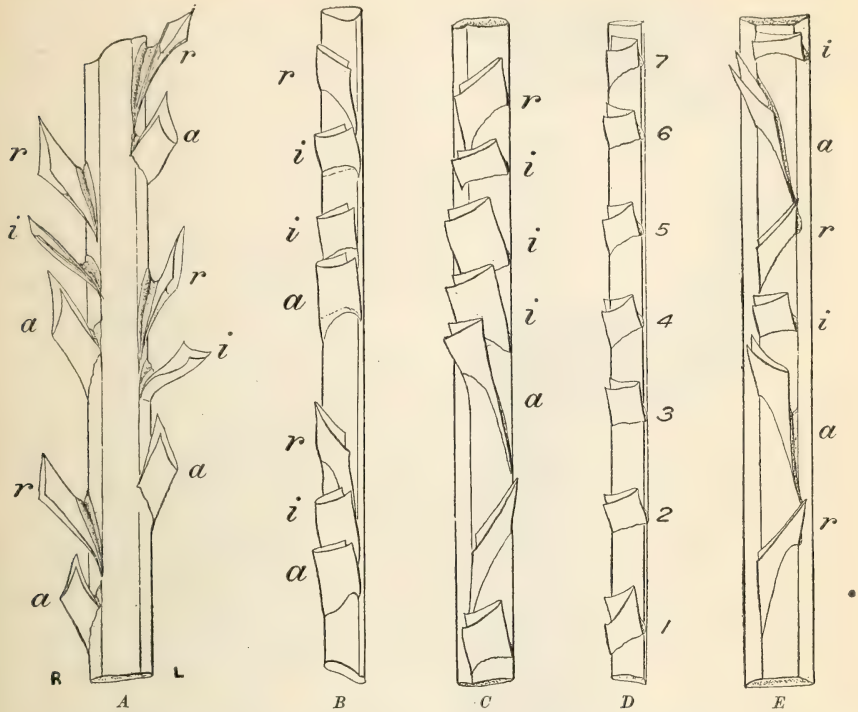


FIG. 5.—Sections of date leaves. *A*, An Areshti leaf. On the L side of the rachis is shown a triple group of pinnæ (a, i, r) and above it a paired group (a, r); on the R side, a paired group (a, r) below and a triple group (a, i, r) above. *B*, Section toward the top of a Deglet Beida leaf, view of right side. Below is a triple group of pinnæ (a, i, r); above, a quadruple group (a, i, i, r). *C*, A Deglet Beida leaf, showing on the left-hand side of the rachis a quintuple group of pinnæ (a, i, i, i, r). The pulvinus of the antrorse pinna (a) is caudate, having a tail-like prolongation reaching nearly to the next lower pinna. *D*, Section near the apex of an Areshti leaf, in which the pinnæ are not distinguishable into groups, though Nos. 1, 4, and 7 are slightly retrorse in position. *E*, A Deglet Beida leaf, showing pulvini of antrorse pinnæ: *a*, *a*, Caudate; *a*, *i*, *r*, coalescent with the groups above and below by these prolonged pulvini.

divergence from the midrib, or rachis, measured by its angles of divergence from the imaginary leaf planes. The antrorse pinnæ diverge least from the plane of the rachis, pointing strongly forward, and their two ranks most nearly approach each other, thus forming the greatest angle with the plane of the blade. The introrse pinnæ are placed most nearly at right angles with the plane of the rachis, or rib, and more nearly to the plane of the blade than the antrorse.

The retrorse pinnæ generally point far forward, their divergence from the plane of the rachis being slightly greater than that of the

antrorse pinnæ. They may lie nearly in the plane of the blade, but they usually form angles back of that plane which must be measured dorsally.

Toward the base of the blade the groups may irregularly coincide on opposite sides of the rachis, giving the pinnæ a tufted appearance

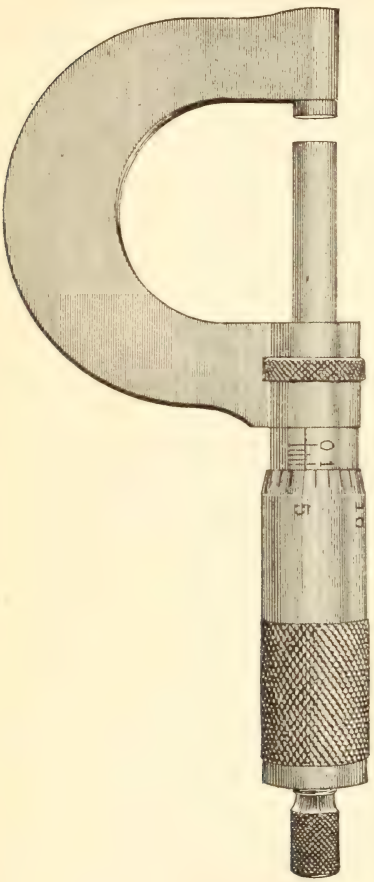


FIG. 6.—Micrometer, reading to 0.001 of an inch, for determining the comparative thickness of pinnæ of date leaves of different varieties.

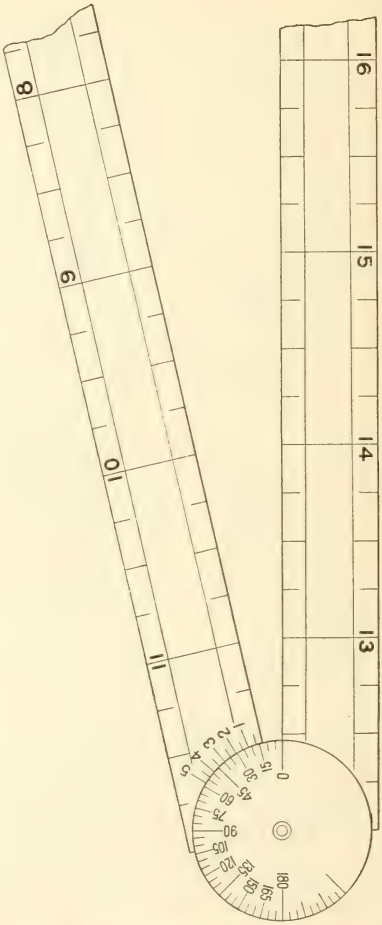


FIG. 7.—Combination 2-foot rule and protractor with vernier for determining the angles at which date-leaf pinnæ diverge from the rachis.

and leaving naked spaces of several inches between them. In other examples the groups may be coalescent through the caudate pulvini, or they may be so crowded that the pinnæ overlap like the slats in a window blind.

Figure 5, *E*, shows on the left side of a section a triple group in the middle, but coalescent with the groups above and below by the caudate pulvini of the antrorse pinnæ.

THICKNESS OF THE PINNÆ BLADE.

The pinnæ in different varieties vary considerably in texture as well as in actual thickness of the blade. Some are decidedly harsh to the touch, while those of the other extreme have a smooth, almost silky feel. Relative differences in thickness of the blades would be detected by the careful observer by comparison, but by the use of a machinist's micrometer this thickness can be made a matter of record. These instruments are graduated to read to 0.001 of an inch or to 0.01 of a millimeter and should have the improved locking device and safety ratchet for regulating the pressure.[1] (Fig. 6.) For uniformity the measurement should be made at about the broadest part of the pinna blade and near the middle of one of the folds. A number of the more familiar varieties have pinnæ that range from 0.012 of an inch (0.3048 mm.) to 0.020 of an inch (0.5080 mm.) in thickness. Others are distinguished by the greater thickness of the blade, as Thoory, with pinnæ from 0.023 of an inch (0.5842 mm.) to 0.026 of an inch (0.6604 mm.) or more in thickness.

USE OF THE FIELD PROTRACTOR.

For the measurement of the angles formed by the pinnæ with the rachis, or rib, a protractor with rather long arms is essential. As one of the necessary capacity made with the fine graduations called for in engineering is both cumbrous and expensive, a single-jointed, 2-foot metal rule, with 5-degree graduations on the hinge circle [2] and vernier reading to degrees and half degrees on the limb, has been found to be a very convenient instrument, giving the angles with sufficient precision and being instantly available for measurements in feet and inches. (See fig. 7.)

FORMS FOR THE OBSERVER'S USE.

For the field recording of characters the writer has devised a ruled and printed form, a reduced imprint of which is shown as form A.

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[1] These instruments are furnished by tool makers in this country for the use of mechanics engaged in fine work, graduated in fractions of an inch or decimal equivalents. They may also be obtained by special order graduated in hundredths of a millimeter.

[2] The hinge circle is graduated five-eighths of the way around into spaces of 5 degrees each and figured 15°, 30°, 45°, etc., from the zero point at the inner angle when the rule is closed. Any angle a multiple of 5 degrees can accordingly be read with accuracy on this hinge circle, but for the degrees between these marks the aid of the vernier on the movable arm is needed. As will be seen when this rule is closed, a 45-degree space on the arm is graduated into 10 parts, so that one of them is equivalent to $4\frac{1}{2}$ degrees, or one-half degree less than the 5-degree spaces on the circle. Every second space or the equivalent 1 degree of difference is numbered 1 to 5 in order, the 5-line degree coinciding with the 45-degree line on the circle. Now, if the rule be opened a very little, till the first vernier line marking $4\frac{1}{2}$ degrees coincides with the line of the first 5 degrees on the circle, the arm has moved the difference between these, or one-half degree. Open till the second pair of marks coincides, and twice $4\frac{1}{2}$, or 9, degrees of space have been moved to coincide with twice 5, or 10, degrees on the other side, a movement gaining 1 degree. So we may open to 2°, 3°, 4°, etc. In the same way starting on any even 5-degree mark, as 45°, we may open one-half degree, 1 degree, 2 degrees more. Hence, to read any angle that has been taken, read first on the hinge circle to the last full 5-degree mark inside of the angle, then add to this the degrees or half degrees to the coinciding line on the vernier. In figure 7 the rule is opened to an angle of $12\frac{1}{2}$°, 10 degrees being read on the hinge circle and $2\frac{1}{2}$ degrees on the vernier.

The heading provides for entering the tree to be studied, locality, garden, row and tree numbers, and date, below which the sheet is ruled in horizontal lines for noting the angles of the different classes of pinnæ: *A* (antrorse), *I* (introrse), *R* (retrorse). Above the lines, *ax* indicates that the axial divergences of the pinnæ—that is, the angles by which they diverge to the right or left from the rachis—are to be recorded.

Below the lines, P indicates the angles of divergence from the plane that would be formed by a perfectly flat blade. Below these a line provides for the record of the "Length of pinnæ" above the line and the corresponding breadths below, the breadth being noted at the broadest part, the pinnæ blade being unfolded and spread flat.

FORM A.—*Date variety, ..., S. P. I. No. ...., row .., tree .., ... garden.*

[Notes taken ....., 191... Angles of pinnæ with planes of rachis. Distance in feet from base of blade.]

	1	2	3	4	5	6	7	8	9	10	11	12
Antrorse, ax												
P												
Introrse, ax												
P												
Retrorse, ax												
P												
Length of pinnæ												
Breadth "												

Groups.....

.....

Remarks.....

.....

The vertical ruling in form A provides spaces for entries for each foot of blade length from below the first spines to the apex.

For some leaves exceeding a length of 12 feet, the record has to be carried to the ruled spaces below.

The length of the spine area and the total blade length are indicated at the same time. An average leaf being selected, it is thought that one or two characteristic readings to each foot of length from base to apex, usually along one side of the blade only, will record the characters effectively, and that two or three leaves each from as many trees will indicate the leaf characters of a given variety. For varieties of paramount importance, such as Deglet Noor, Thoory, Hayany, and a few more, of course a greater number of records are desirable.

GROUP AND CLASS RECORD.

Following the above comes the record of the classes and groups of pinnæ, made continuously from base to apex along one side of the blade. The lower thorns, usually crowded, when not distinguishable as to class or groups are indicated by a corresponding number of straight marks, then the groups are recorded by the component initial letters written together; for instance, *ar, ar, ar* would indicate three successive groups, each composed of one antrorse and one retrorse pinna.

ANGLE RECORD OF THE PINNÆ.

In order to accomplish the graphic representation of the various angles formed by the pinnæ with the axis and plane of the blade, a diagram has been prepared (form B)[1] representing a semicircular protractor as it might be applied for the reading of the angles recorded on form A.

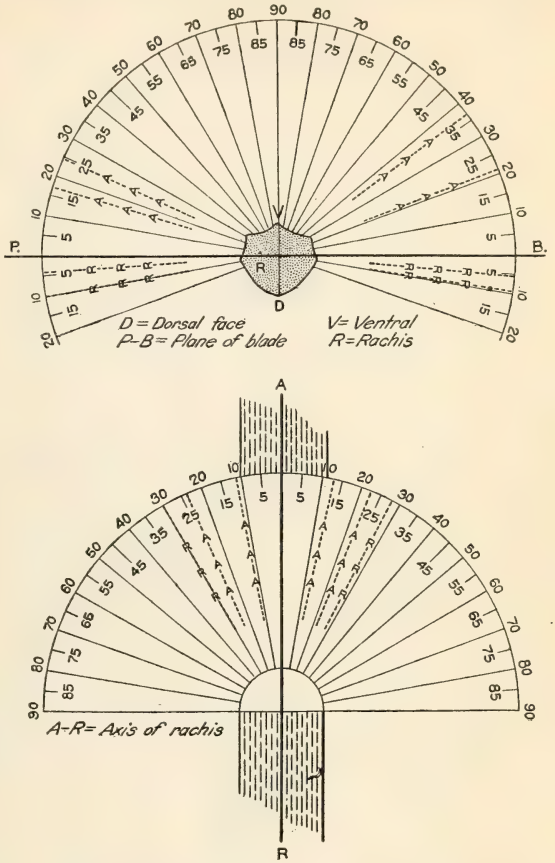


FIG. 8.—Diagrams showing the characteristic divergence of the pinnæ of a Deglet Noor date leaf, at 2 to 3 feet from the base of the leaf, recorded on form B. The upper diagram shows the divergence from the blade plane; the lower, the divergence from the apex: *A*, Antrorse pinnæ; *I*, introrse; *R*, retrorse.

The first illustration of the use of form B (fig. 8) shows the protractor scale as though laid flat upon the leaf, the zero line *AR* drawn through its center being parallel with the axis of the blade and zero toward the apex, the divergence of the right and left ranks of pinnæ would be indicated at 10°, 25°, 45°, etc.

In the second illustration of the use of form B (fig. 9) the protractor is placed as though cross-sectioning the rachis, the zero line *PB* coinciding with the plane of the blade and the line of 90° bisecting the

[1] Form B, reduced in size, is shown in figures 8, 9, and 10.

rachis into two equal parts, right and left. The ventral face of the rib is shown at *V*, the dorsal at *D*.

It will be noticed that in the illustrations of the use of form B (figs. 8–10), the protractor circle is carried 20 degrees beyond the zero plane toward the dorsal face of the rachis. This is for recording the position of the retrorse class of pinnæ, which, while sometimes forming angles of a few degrees toward the inner or ventral side, as a rule lie either at zero or inclined 5°, 10°, or even 20° dorsally.

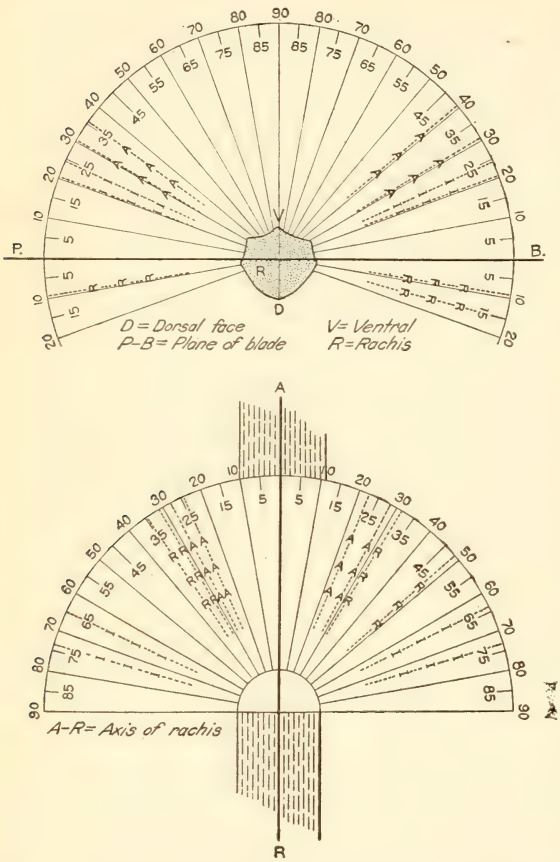


FIG. 9.—Diagrams showing the characteristic divergence of the pinnæ of a Deglet Noor date leaf, at 5 to 6 feet from the base of the leaf, recorded on form B. The upper diagram shows the divergence from the blade plane; the lower, the divergence from the apex: *A*, Antrorse pinnæ; *I*, introrse; *R*, retrorse.

APPLICATION OF THE SYSTEM TO THE DEGLET NOOR VARIETY AND ITS SEEDLINGS.

As the Deglet Noor is the most prominent variety of date yet introduced, a more extensive study of its foliage characters has been made than of any other variety. The following are some of the most striking points brought out:

The average of eight examples of Deglet Noor leaves gives the spine area as 35.5 per cent of the blade length.

For the same trees the average proportion of pinnæ of the different classes, including spines where the class is evident, to the total number on the blade, is as follows: Antrorse, 38.1 per cent; introrse, 19.4 per cent; retrorse, 34.1 per cent; uncertain, 8.4 per cent. The paired groups of pinnæ exceed all the others together.

A larger number of observations of this variety may establish a somewhat different set of ratios, but these must serve for a working basis till such can be procured.

As showing the application of such study of the leaves of a given variety and its value in selecting plants for breeding purposes, a com-

parison will be made of some of the Deglet Noor seedlings with the average for that variety, or what may be called a standardized tree.

Two sets of readings were taken from the Deglet Noor fruiting seedling raised by Mr. James Reed, at Thermal, Cal. In both of these the data are well within the range of variation of the eight true Deglet Noor records, and the average of the two is curiously near to the average of the Deglet Noor. The pinnæ are more closely crowded than in any of the Deglet Noor records, and the percentage of introrse pinnæ is above the average, but within the range.

The proportion of paired, triple, and quadruple groups of pinnæ is remarkably near the average. The fruit of this presumably half-blood Deglet Noor seedling has not been distinguishable from that of the standard imported Deglet Noor varieties. No other Deglet Noor seedling has been found so closely duplicating the Deglet Noor in fruit.

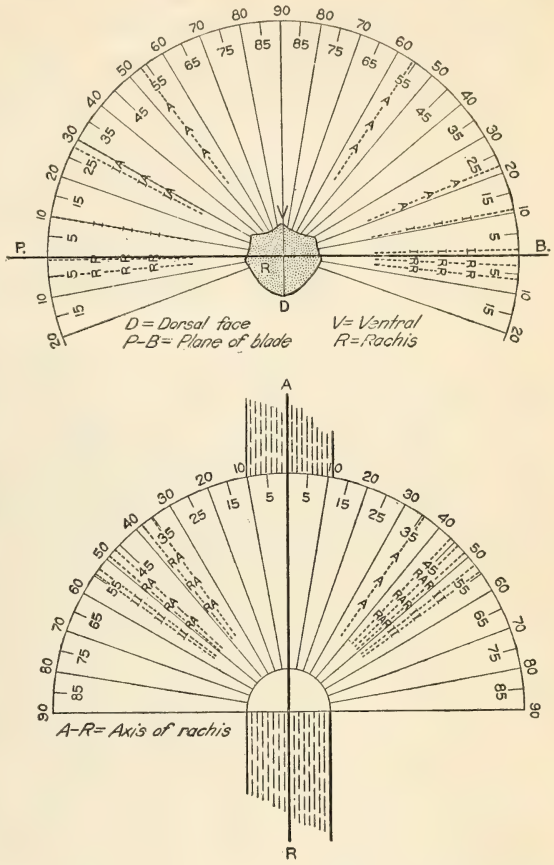


FIG. 10.—Diagrams showing the characteristic divergence of the pinnæ of a Deglet Noor date leaf, at 8 to 9 feet from the base of the leaf, recorded on form B. The upper diagram shows the divergence from the blade plane; the lower, the divergence from the apex: *A*, Antrorse pinnæ; *I*, introrse; R, retrorse.

Of others that have fruited, showing decided Deglet Noor characters in color, flavor, or texture of the fruit, none has been found with the same close approximation to Deglet Noor foliage. In a slender-fruited seedling, for example, raised by the California Date Co., at Heber, Cal., the fruit has the Deglet Noor flavor and texture in a high degree. The form of this fruit is long and slender, entirely distinct from the Deglet Noor. Referring to Table I, showing the point characters, this variety, as compared with the Deglet Noor,

has the spine area shorter than any of the true Deglet Noor measurements, while the pinnæ are more crowded and have lower percentages of antrorse and retrorse pinnæ and higher percentages of introrse and undetermined pinnæ.

There are also a lower percentage of double groups of pinnæ and higher percentages of triple and quadruple groups than have been noted in any true Deglet Noor. On the whole it is considerably outside the recorded range of variation for the Deglet Noor variety, though nearer the type than the average of supposed half bloods.

It seems to be a good working hypothesis that there is a close correlation between the leaf and fruit characters of the date tree. If this be true, we should look for male trees having the leaf characters within the range of Deglet Noor variation to give us trees most capable of transmitting Deglet Noor qualities where used as pollinators. Failing in this quest, we must use those coming the nearest to such character.

So far, no male trees have been found among the Deglet Noor seedlings which correspond to the best Reed seedling in being nearly true to foliage type. Mr. Reed's seedling male trees Nos. 1 and 2 are trees of a strong Deglet Noor character, but fall considerably short of the type. However, they have been used as pollinators, and many seeds of Deglet Noor fruit of such pollinations have been sown, but none are old enough to have proved themselves.

TABLE I.—*Comparison of the average leaf characters of four important varieties of date palms.*

Average leaf characters.	Deglet Noor.	Deglet Noor, Reed's seedling.	Deglet Noor, slender-fruited seedling.	Hayany.	Menakher.	Thoory.
Blade length.....inches..	126	116	110	122	144	126
Spine area:						
Length.....do....	43	38	24	23	32	32
Percentage of blade length	35.5	33	22	18	22	25.6
Total number of pinnæ on one side of rachis.....	91	98	96	96	122	69
Distribution:						
Antrorse.....	32	35	30	31	27	25
Percentage of total.....	35+	36−	31+	32+	22+	36+
Introrse.....	20	24	26	19	58	16
Percentage of total.....	22−	24+	27+	20−	47−	23+
Retrorse.....	30	32	29	33	35	21
Percentage of total.....	33−	33−	30+	34+	29−	31−
Undetermined.....	9	7	11	13	2	7
Percentage of total.....	10−	7+	12−	14−	2−	10+
Number of groups of pinnæ:						
In groups of two.....	20	22	11	27	12	15
Percentage of total.....	61−	67−	40.7+	77+	32+	60
In groups of three.....	9	8	8	7	19	8
Percentage of total.....	27+	24+	29.6	20	52	32
In groups of four.....	4	3	8	1	6	2
Percentage of total.....	12+	9+	29.6	3	16+	8
Thickness of pinnæ:						
Inches.....	0.016–0.022	0.016–0.018	.....	0.017–0.020	0.017–0.022	0.022–0.030
Millimeters.....	.4064–.5588	.4064–.4727	.....	.4318–.5080	.4318–.5588	.5588–.7620

In the analysis of these characters (Table I) the Deglet Noor has the highest percentage of spine area to total blade length and Hayany the lowest. Menakher stands out from the group in having nearly half of its pinnæ of the introrse class, while Hayany has the lowest percentage of any in that class. While Deglet Noor, Hayany, and Thoory have a majority of their pinnæ groups of the paired class, Hayany leads in that respect in having but a fraction short of four-fifths of its pinnæ groups in the paired class. Menakher, on the other hand, has a majority of its groups of the triple class.

The descriptions of four date varieties which follow are given as showing the application of this system of leaf study to the dates in cultivation. Among the many varieties being tested in the gardens of the Department of Agriculture these four take first rank in their respective classes and present such a wide range in leaf characters as to illustrate very clearly the principles involved.

DESCRIPTION OF THE DEGLET NOOR VARIETY.

The trees of the Deglet Noor variety have slender trunks and make a rather rapid height growth, the leaves being 9 to 11 feet long, erect spreading, forming a rather narrow vase-shaped top, becoming broader with age. The leaf base is narrow, diminishing to a firm, gradually tapering rib, which has a slight, graceful flexibility at the apical portion. It is strongly rounded dorsally, well arched ventrally, with the lateral faces of more than average breadth (fig. 11).

The spine area averages about 35 per cent of the blade length, the spines firm, with stout bases, rather long, acuminate, acutely pointed, crowded below, more scattered in the upper portion of the area, and decidedly appressed. They pass to narrow spikelike pinnæ, 12 to 18 inches in length, and the longest pinnæ, 24 to 27 inches, are reached at about the middle of the blade while but 1 inch to $1\frac{1}{8}$ inches broad. The greatest breadth of the pinnæ, $1\frac{3}{8}$ to $1\frac{1}{2}$ inches, is usually at about 6 to 7 feet from the base, where the pinnæ are 20 to 24 inches long. They diminish steadily to 10 or 15, or rarely 18 inches, in length and seven-eighths of an inch to 1 inch in breadth at the apex of the leaf. The pinnæ throughout are acuminate in form and acutely pointed, varying in thickness of the blade from 0.016 of an inch (0.4064 mm.) to 0.022 of an inch (0.5588 mm.), from 0.017 of an inch (0.1318 mm.) to 0.020 of an inch (0.5080 mm.) being the most common, the texture being firm and rather harsh than soft. The blades are closely folded, and toward the apex of the leaf the proximal fold is slightly wider than the distal and decurrent along the rachis. The pulvini toward the base of the blade are heavy, sometimes strongly caudate, but the groups are seldom coalescent.

The paired groups of pinnæ are in the majority, often comprising 60 to 70 per cent of the whole number, while there are about 22 to 30 per cent of the triple groups, and a few are quadruple.

The antrorse pinnæ comprise from 34 to 42 per cent of the whole number, the retrorse class furnishing from 31 to 36 per cent, while of

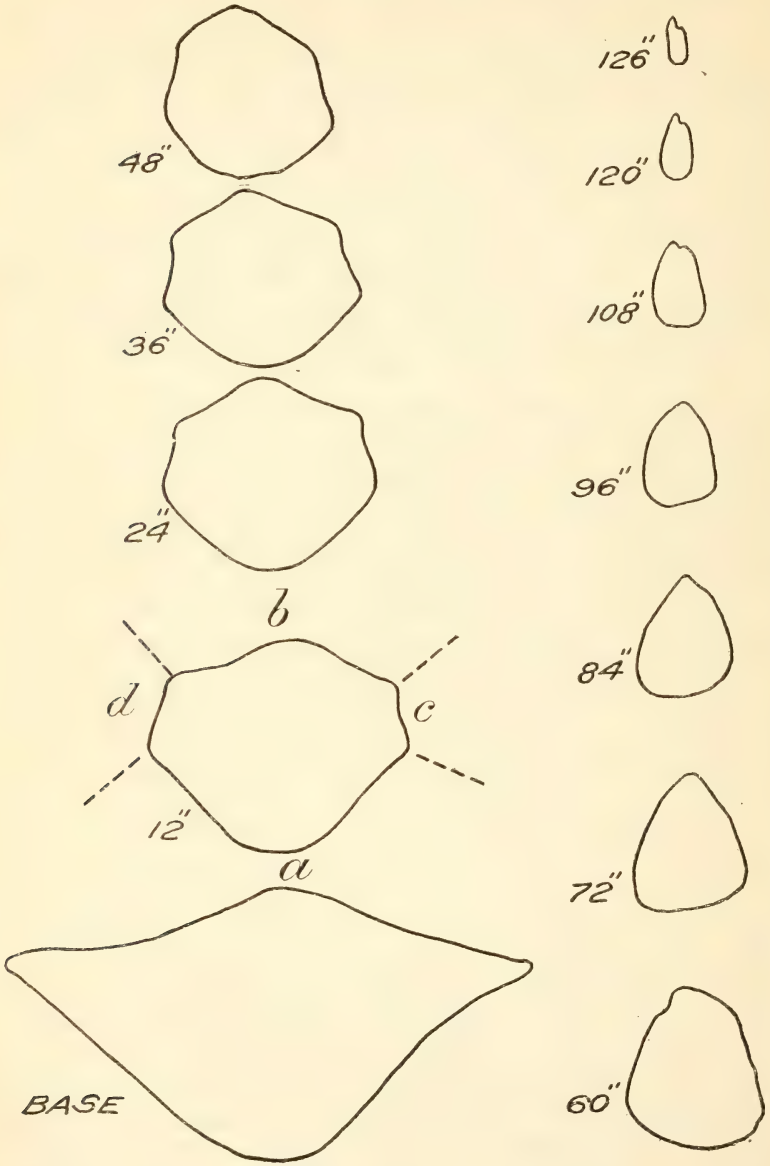


FIG. 11.—Cross sections of the rachis of a Deglet Noor date leaf, showing outlines at different distances from base to apex.

the introrse pinnæ there are but 15 to 25 per cent. Unclassified basal spines make up the balance.

In divergence from the rachis, the antrorse spines are usually rather closely appressed, a divergence of only 5° is noted in some, and other spines may diverge 25° or 30° from the axis. In some leaves the entire rank of antrorse pinnæ to the apex may not diverge more than 25° to 28°, but usually there is a spread through the middle of the blade of 35° to 42° interspersed with others of only 20° to 23°. In divergence from the plane of the blade, the antrorse class among the spines shows a good deal of variety, some basal ones diverging sharply, the majority only from 12° or 15° to 20° to 30° or more. From the middle of the blade to the apex their divergence is from 20° to 30° or rarely 40°, 45°, or more.

The introrse class, seldom found among the spines in this variety, shows strong axial angles of 40° to 50° and up to 72°, while from the blade plane their divergence ranges from zero to 15°, 20°, or 25°, a few forming angles of 35°, 40°, or even more.

In the retrorse class a few spines may stand out strongly from the rachis, but the majority are rather appressed. The retrorse pinnæ as a rule spread more than do the antrorse class at the same distances out on the blade, ranging from 24° to 40°, 45°, or 48°.

Measured from the blade plane this class has a distinct position, some being placed at zero or at 5° ventrally, but the great number incline backward from the plane, forming dorsal angles of 5° or 10°.

For a comparison of Deglet Noor seedlings of various grades with the pure variety, the above percentages and records of angles will be found to afford the means for making very close distinctions. This is important, from the fact that thus far comparisons seem to show a strong correlation between leaf and fruit characters, the seedlings bearing the nearest typical Deglet Noor fruit showing Deglet Noor leaf characters in greatest detail. By analogy, it is presumed that there will be a similar correlation between the leaf characters of male seedling trees of a given variety and their capacity for transmitting the characters of that variety when used as pollinators.

Putting the above dry array of figures into concrete form shows that the Deglet Noor has a suit of leaves thoroughly well armed at all angles of approach, especially the lower portion of the blade, with acute spines and sharply tipped pinnæ. The protection of the tender emerging leaves, but especially of the emerging flower stalks, is well provided for. In cultural practice the operator in our country is accustomed to clip off with stout shears the most of the spines, in order to give him access to the flower heads for pollination.

The fruiting stalks, or sobata, of the Deglet Noor are one of its most characteristic features. (Fig. 12.) They are, with the strands, or shamrokh, which bear the fruit, pale lemon colored in contrast with the orange-yellow or orange stalks of most varieties. They are un-

usually long, from 3 up to 4 or 5 feet, and $1\frac{1}{4}$ to $1\frac{1}{2}$ inches broad on mature trees. The fruiting head, or portion bearing the strands, is short, the strands numerous, often 18 to 24 inches, or occasionally 27 to 30 inches long, sometimes forked. The proximal naked portion of the strand (one-third to one-half of the length) is sharply and irregularly quadrangular in cross section, the fruiting portion irregularly oval, with short zigzag angles. From 20 to 30 fruits are sometimes set on a single strand. With the growth of the fruit in weight, the stalk curves downward, till the entire load often hangs suspended nearly vertically.

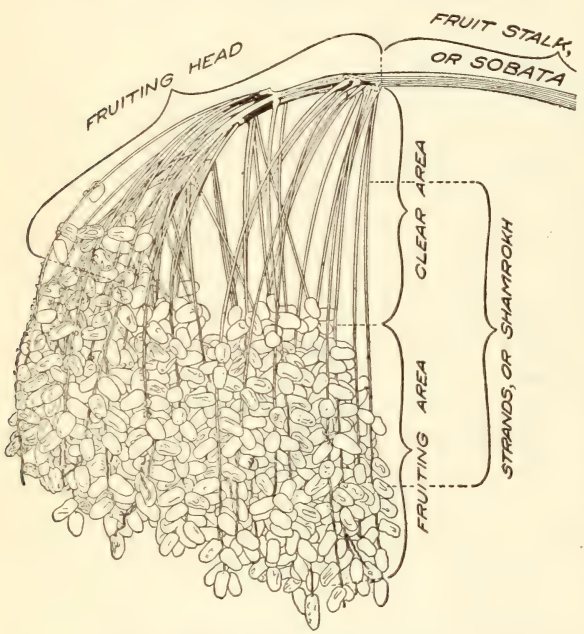


FIG. 12.—A bunch of dates of the Deglet Noor variety, showing the fruit stalk, or sobata; the fruiting head, or portion on which the strands are borne; and the strands, or shamrokh, comprising the clear area and the fruiting area.

DESCRIPTION OF THE HAYANY VARIETY.

(Birket el Haggi, Birket el Hajji,[1] Birket el Hadji.)

The trees of the Hayany variety have rather slender trunks and moderate outcurve of leaves, forming a broadly vase-shaped top.

The leaf bases are rather coarse, broadly wedge shaped, narrowing abruptly to a wedge-shaped petiole. The rachis is of medium size, well rounded dorsally, and the lateral faces rather broad, the size diminishing gradually, but there is a decided grace and flexibility toward

[1] Several trees of this variety were received by the Office of Foreign Seed and Plant Introduction under the name of "Birket el Haggi" from Mr. Em. C. Zervudachi, of Alexandria, Egypt, in 1901, and listed under S. P. I. No. 7635. Upon fruiting they proved to be identical with "Hayany," S. P. I. No. 6138, secured by Mr. Fairchild earlier in the same year. Hayany is the correct name of the variety, which is the most numerous and most popular date of Lower Egypt. The name "Birket el Haggi" is only mentioned among Egyptian dates by Delchevalerie, who erroneously mistook the locality designation for the real name of the variety.

On the writer's visit to the Birket el Hagg district in September, 1913, he found that the people knew of no date named "Birket el Haggi," but that they had thousands of "Hayany" trees, the fruit of which was among the earliest to reach the Cairo and Alexandria markets, and so took the locality name, as "Chautauqua grapes" or "Riverside oranges" do in our country. Popenoe, "Date Growing in the Old and New World," adopts the form "Birket el Hajji," in conformity with classic Arabic pronunciation, though "Birket el Hagg" is the correct transliteration of the name of the pool and village accepted by all Egyptians and is on most of their maps.

the apex of the leaf (fig. 13). The spine area is unusually short, about 18 to 25 per cent of the blade length, and the spines are rather long, slender and acute; where considerably shaded they are inclined to be weak and soft. The spines merge into narrow spike pinnæ, followed by ribbon pinnæ 24 to 30 inches long and one-half to five-eighths of an inch wide, which are frequently pendulous, but soon give place through the middle of the blade to those of normal form, 18 to 24 inches long and 1 inch to $1\frac{1}{4}$ inches up to $1\frac{1}{2}$ or 2 inches wide with narrow attenuate tips, gradually diminishing to about 10 or 12 inches long at the apex. The pulvini are but moderately developed and creamy in color.

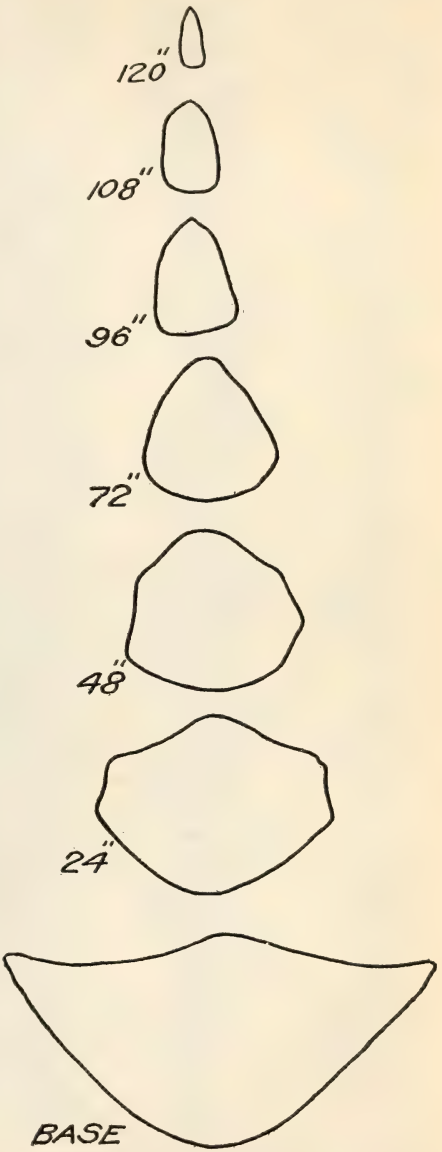


FIG. 13.—Cross sections of the rachis of a Hayany date leaf, showing outlines at different distances from base to apex.

The lower 10 or 15 pinnæ on either side have a solid neck, which will be called the collum, from one-half inch to 2 inches in length, just above the pulvinus, from which the pinnæ expand into the folded blade of normal form. These are most strongly developed on the retrorse class of pinnæ. This character, while slightly developed in a few other Egyptian varieties, is almost an identifying character for this variety. The pinnæ blades are smooth and rather soft, not rigidly acute at the apex, but inclined to split up. The axial divergence of the pinnæ is, for the antrorse class, only about 20° to 35° near the base, becoming 45° or 50° toward the apex. The introrse and retrorse classes diverge more strongly, in some leaves to 60° or 65°. In divergence from the plane of the blade the antrorse pinnæ

form ranks which diverge 30° or 40° to 55° or 60°, while the introrse and retrorse pinnæ lie within 10° of the planes or diverge a little dorsally.

At Tempe, in a heavy adobe soil with an excess of subterranean moisture, this variety has been prolific in offshoots and sets them well up on the trunk, one tree as early as 1909 having six offshoots at a height of 4 to 4½ feet.

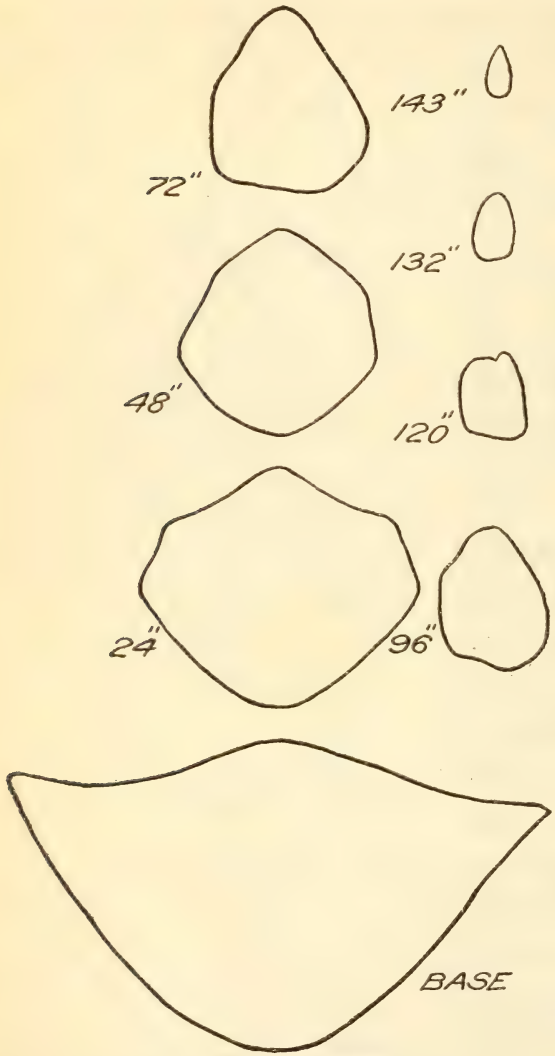


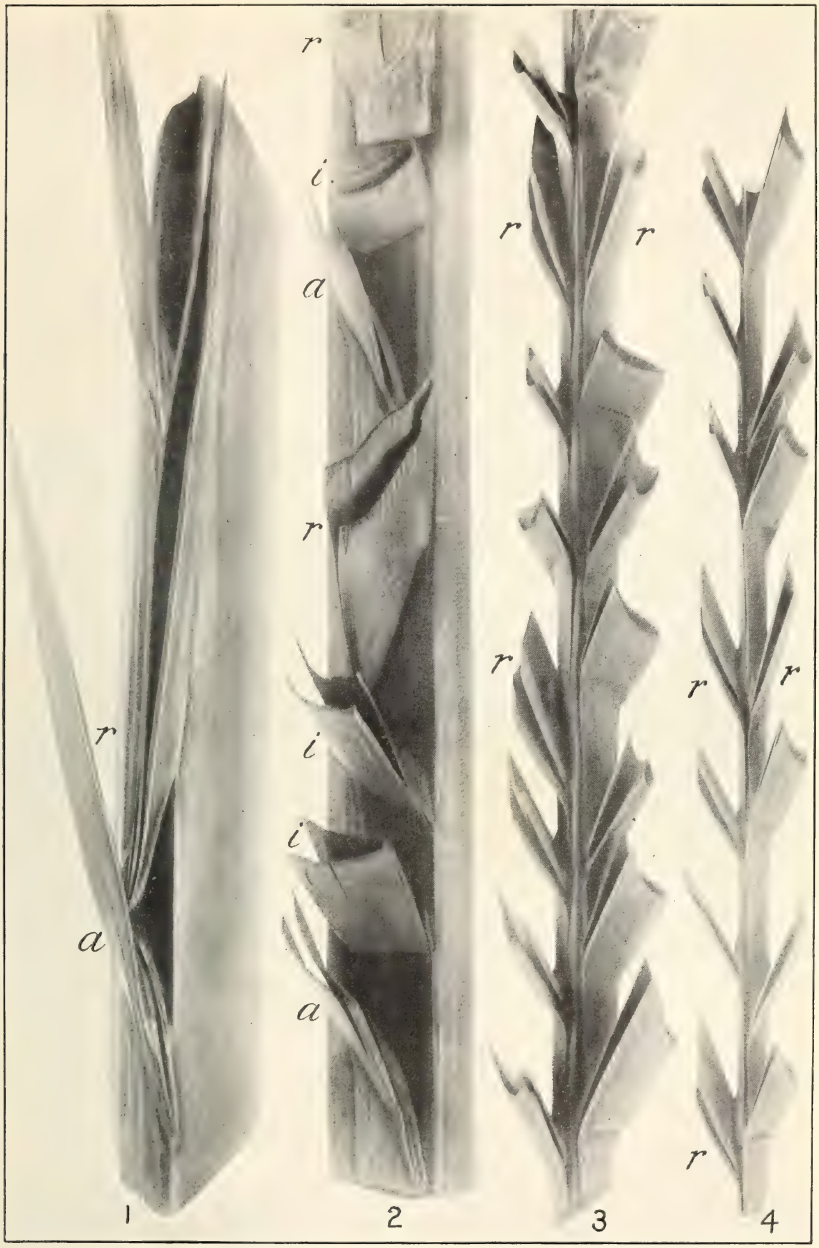
FIG. 14.—Cross sections of the rachis of a Menakher date leaf, showing outlines at different distances from base to apex.

The fruit stalks are orange yellow, about 2½ or 3 feet long, 1¾ to 2 inches broad, the fruit head compact and heavy, and the strands, or shamrokh, of medium length and rather coarse.

DESCRIPTION OF THE MENAKHER VARIETY.

The trees of the Menakher variety are of beautiful and striking appearance. The growth is vigorous, though not as rank as some other varieties, and the height growth of the trunk has been rather slow.

The foliage is a dark rich green, with abundant glaucous bloom. The leaves are 9 to 12 feet long, curving outward rather stiffly below, but with an increasing flexibility toward the apex, which gives a long and beautiful sweep. The leaf bases are 7 to 9 inches broad, heavy, narrowing gradually to a stout, strongly rounded rib, which tapers slowly to a moderately slender apex (fig. 14).



FOUR SECTIONS OF A MENAKHER DATE LEAF. (NEARLY NATURAL SIZE.)

FIG. 1.—A leaf section near the base, showing a paired group, *a*, *r*, of very acute spines. FIG. 2.—A section at 8 feet, showing a quadruple group, *a*, *i*, *i*, *r*, below and a triple group, *a*, *i*, *r*, above. FIGS. 3 and 4.—Sections at 10 and 12 feet, showing some well-defined retrorse pinnæ, *r*, *r*. The others will class as introrse, and no regular groups can be determined.

The spine area is from 20 to 25 per cent or more, rarely 33 to 36 per cent of the blade length. The closely set spines are short or of medium length, strong, but acute, closely appressed, passing to narrow spike pinnæ 20 to 24 inches long. The regular pinnæ at 5 to 6 feet from the leaf base are 17 to 24 inches long, $1\frac{1}{4}$ to $1\frac{3}{4}$ inches broad, decreasing in length rather gradually to about 9 to 12 inches long at the apex. (Pl. V.)

The pinnæ blades are 0.017 of an inch (0.4318 mm.) to 0.022 of an inch (0.5588 mm.) thick, firm in texture but not harsh, broadest near the base, tapering evenly to a rather acuminate acute apex. In the upper portion of the leaf the proximal fold of the pinnæ blade is decidedly broader than the distal, decurrent along the rachis, but the prominence of the ventral arch of the rachis leaves the channel formed by opposite wing margins rather open until near the top of the blade.

The pulvini are moderately heavy, frequently slenderly caudate, and there are many coalescent groups in the lower portion of the blade. The paired groups of pinnæ are considerably outnumbered by the triple and quadruple groups. The introrse pinnæ usually comprise from 40 to 48 per cent of the entire number on the blade, but sometimes yield to a high number of the retrorse class.

The slight axial divergence of all classes of pinnæ and the rather even and moderate divergence from the blade plane give to this variety a smooth, even leaf, which, with its dark, rich color, is very attractive.

The antrorse spines have but 10° to 15° of axial divergence, the lower antrorse pinnæ 15° to 20°, spreading to 30° toward the tip of the leaf.

The antrorse pinnæ diverge axially about 45° through the middle of the blade and 30° at the apex. Both these classes form angles with the blade plane of 20° to 30° or 36° in the outer 2 feet.

The axial angles of the retrorse pinnæ are a little greater than in the first-named classes, the lower pinnæ 20° to 28° or 30°, the rest of the blade 30°. These spines diverge about 15° dorsally, the pinnæ 5° dorsally, or all the upper portion at zero. In a few instances the retrorse spines and lower pinnæ have a dorsal divergence of 30° to 33°.

The fruit stalks are heavy, 3 to 4 feet long, the fruiting head 12 to 15 inches long, with numerous strong strands 12 to 18 inches in length, making a heavy, compact bunch of fruit.

But two genuine trees of the Menakher variety were finally preserved of the importation made by Mr. T. H. Kearney in 1905. One of these is at the Cooperative Date Garden at Tempe, Ariz. The other is at Mecca, Cal. The Tempe tree has made the slower growth, though it is a healthy and vigorous-looking tree. In November, 1912, its terminal bud was only 3 feet from the ground, while that of the Mecca tree was 7 feet high, with a trunk diameter of 2 feet. Whether

the greater heat at Mecca or the difference in the soil is the cause of this difference in growth is not easy to say. The Tempe garden is located in a strip of land having a heavy adobe soil and so high a percentage of alkali that ordinary grain and forage crops can not be grown upon it. By the underflow of ground water from irrigated districts above, the water table has not been below 4 feet for a number of years and stands near the surface in the winter months.

The conditions at the Mecca garden are in strongest contrast with these. The soil is a fine sand, the bed of the old Salton fresh-water lake, having a considerable percentage of calcareous material in the form of partially decayed small fresh-water shells, and underlain with a few shallow strata of blue clay or silt. The only organic matter has been supplied by cover crops and the liberal application of stable manure around the roots of individual trees.

There is but a slight trace of alkali, and irrigation with very pure water from an artesian well has been abundant. While too positive conclusions should not be drawn from the behavior of a single tree in each locality, a similar slowness of growth has been noted in several trees of Thoory at Tempe, as contrasted with a very vigorous and rapid growth of that variety at Mecca and Indio. At the same time a number of varieties, such as Deglet Noor, Rhars, Itima, and Tadala, under Tempe conditions have made a rather better growth than in the sandy soil and greater heat of Mecca.

The presumption is strong that the Menakher variety finds both the temperature and the sandy soil, with the absence of the alkali of the Mecca garden, the more congenial. In fruiting, both trees have been slow to develop fruit of normal quality, but have improved from year to year. At Tempe, however, it hardly seems likely that this variety has heat enough to perfect its fruit. While a good crop was set in 1912, it was found still immature on November 10. Some fruits were coloring properly on one side and had ripened a portion of the flesh, which was of excellent flavor, but the most of them were tough and "cottony," and a good sample box could not have been collected. At Mecca a good deal of fruit developed sufficiently to be finished by "slow maturation" into a very excellent product. The rarity of this variety in Tunis and the consequent scarcity of offshoots that may be purchased will probably prevent its assuming commercial importance in the Salton Basin for many years to come.

Yet, considering the past year's performance of the Mecca tree, the writer feels that the Menakher should be regarded as promising to become one of the great commercial dates of the Salton Basin when it can be propagated in sufficient numbers.

DESCRIPTION OF THE THOORY VARIETY.

The trees of the Thoory variety are of very robust growth, with short heavy trunks. The long, heavy, rather yellowish green leaves

are stiffly erect or spreading in an angular manner by bending near the base. The leaf bases are 5 to 8 inches broad, diminishing gradually

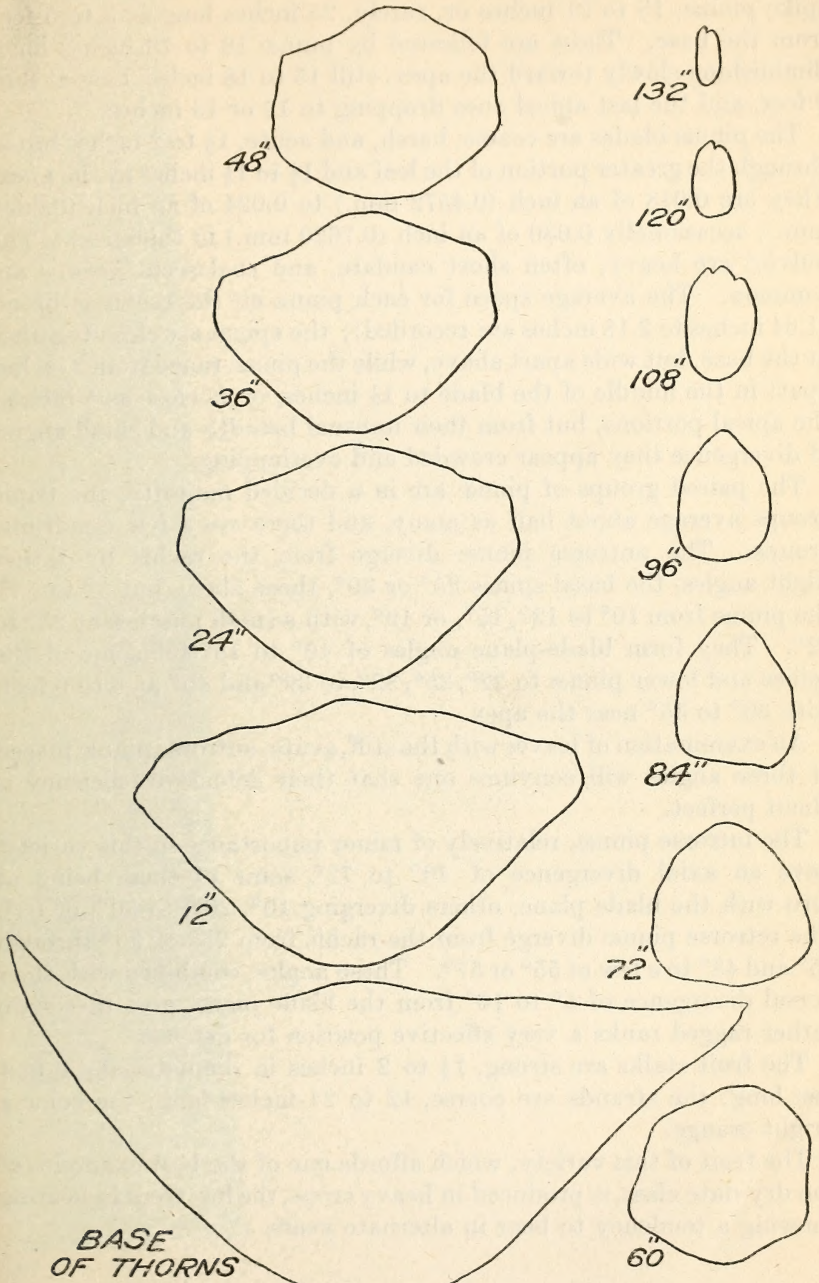


FIG. 15.—Cross sections of the rachis of a Thoory date leaf, showing outlines at different distances from base to apex.

to a broad, heavy rib, which tapers but slowly to the apex, where there is a slight flexibility (fig. 15).

The spine area is short, 15 to 30 per cent of the blade length, the sparsely set spines rather short, slender, acute, passing to a few stout spike pinnæ, 18 to 21 inches or, rarely, 25 inches long at 3 to 5 feet from the base. These are followed by pinnæ 18 to 23 inches long, diminishing slowly toward the apex, still 15 to 18 inches long at 8 or 9 feet, and the last apical ones dropping to 12 or 13 inches.

The pinnæ blades are coarse, harsh, and acute, 1½ to 2 inches broad through the greater portion of the leaf and 1¼ to 1½ inches at the apex. They are 0.018 of an inch (0.4572 mm.) to 0.024 of an inch (0.6096 mm.), occasionally 0.030 of an inch (0.7620 mm.) in thickness. The pulvini are heavy, often short caudate, and coalescent groups are common. The average space for each pinna on the rachis is broad (1.64 inches to 2.18 inches are recorded); the spines are close together at the base, but wide apart above, while the pinnæ range from 2 inches apart in the middle of the blade to 1¼ inches, or as close as 1 inch in the apical portions, but from their unusual breadth and small angles of divergence they appear crowded and overlapping.

The paired groups of pinnæ are in a decided majority, the triple groups average about half as many, and there are a few quadruple groups. The antrorse pinnæ diverge from the rachis by rather slight angles, the basal spines 25° or 30°, those above but 5° to 15°, the pinnæ from 10° to 12°, 15°, or 19°, with a small number at 25° to 32°. They form blade-plane angles of 10° to 15° for some of the spines and lower pinnæ to 22°, 25°, 32°, to 39° and 40° at 6 to 9 feet, with 30° to 35° near the apex.

An examination of leaves with the stiff, acute, antrorse pinnæ placed at these angles will convince one that their defensive efficiency is about perfect.

The introrse pinnæ, relatively of minor importance in this variety, have an axial divergence of 40° to 72°, some of them being at zero with the blade plane, others diverging 10°, 20°, to 30°, or 63°. The retrorse pinnæ diverge from the rachis from 25° or 30° through 35° and 48° to a few at 55° or 57°. These angles, combined with their dorsal divergence of 5° to 10° from the blade plane, give these two rather ragged ranks a very effective position for defense.

The fruit stalks are strong, 1½ to 2 inches in diameter and 2 to 4 feet long; the strands are coarse, 12 to 24 inches long; the color a bright orange.

The fruit of this variety, which affords one of the best examples of the dry-date class, is produced in heavy crops, the few trees in bearing showing a tendency to bear in alternate years.